1 We claim:

1   1.   A method to update code in an information storage and retrieval system

2 while that system remains in normal operation, comprising the steps of:

3   providing an information storage and retrieval system comprising one or more

4 processors;

5   providing existing code, wherein said one or more processors use said existing

6 code to operate said information storage and retrieval system, and wherein said existing

7 code includes a Concurrent Code Load having (N) phases;

8   generating a code update image comprising a Temporal Coupling File, wherein

9 said Concurrent Code Load includes instructions to read said Temporal Coupling File;

10   providing said code update image to said information storage and retrieval

11 system;

12   executing the (i)th phase of said Concurrent Code Load, wherein (i) is greater

13 than or equal to 1 and less than or equal to (N), and wherein (i) is initially set to 1;

14   determining if said (i)th phase of said Concurrent Code Load invokes said

15 Temporal Coupling File;

16   operative if said (i)th phase of said Concurrent Code Load invokes said Temporal

17 Coupling File, reading instructions for said (i)th phase of said Concurrent Code Load

18 from said Temporal Coupling File, and executing said instructions for said (i)th phase of

19 said Concurrent Code Load;

20   completing said (i)th phase of said Concurrent Code Load;

21   ascertaining if (i) equals (N);

22   operative if (i) equals (N), operating said information storage and retrieval system

23   using said code update.

1   2.   The method of claim 1, further comprising the steps of:

2   operative if (i) does not equals (N):

3   incrementing (i);

4   repeating said executing, determining, completing, and ascertaining steps, and

5   optionally said reading, executing, and incrementing steps.

1   3.   The method of claim 1, further comprising the steps of:

2   providing a Concurrent Code Load which includes (N) indicators, wherein each of

3   said (N) indicators is assigned to a different one of said (N) phases, and wherein each of

4   said (N) indicators can have a first value or a second value;

5   wherein said determining step further includes examining the (i)th;

6   operative if said (i)th indicator is set to said first value, ascertaining that the (i)th

7   phase of the Concurrent Code Load does not invoke the Temporal Coupling File; and

8   operative if the (i)th indicator is set to said second value, ascertaining that the (i)th

9   phase of the Concurrent Code Load does invoke the Temporal Coupling File.

1   4.   The method of claim 1, further comprising the step of providing an

2   existing code which includes a Concurrent Code Load comprising 10 phases.

1   5.   The method of claim 1, further comprising the steps of:

2   creating said existing code at a first time;

3   installing said existing code in said information storage and retrieval system at a

4   second time;

5   creating said Temporal Coupling File at a third time, wherein said third time is

6   later than both said first time and said second time.

1   6.   The method of claim 1, further comprising the step of:

2   providing a code update image comprising the (m)th code update, wherein said

3   executing step includes determining if the (m-1)th code update has been installed.

1   7.   The method of claim 6, further comprising the step of determining by said

2   controller if the (m-1)th code update has been installed;

3   wherein said Temporal Coupling File includes instructions which cause said

4   processor to determine if the (m-1)th code update has been installed.

1   8.   The method of claim 7, further comprising the step of generating an error

2   message if the (m-1)th code update has not been installed.

1   9.   The method of claim 1, further comprising the steps of:

2   providing an information storage and retrieval system comprising one or more

3   disk arrays and two or more clusters, wherein each of said two or more clusters includes,

4   a processor, one or more device adapters interconnected to said one or more disk arrays,

5   and said existing code, and wherein said Concurrent Code Load includes quiescing I/O to

6   a first one of said two or more clusters;

7   determining by a controller disposed in said first cluster if one or more device

8   adapters disposed in a second one of said two or more clusters are operational before said

9   first processor quiesces I/O to said first cluster;

10 wherein said Temporal Coupling File includes instructions which cause said first

11 processor to determine if one or more device adapters disposed in said second cluster are

12 operational before quiescing I/O to said first cluster.

1 10. The method of claim 9, further comprising the step of generating an error

2 message if one or more device adapters disposed in said second cluster are not

3 operational.

1 11. An article of manufacture comprising a computer useable medium having

2 computer readable program code disposed therein to update code in said article of

3 manufacture while that article of manufacture remains operational, said article of

4 manufacture further comprising one or more processors and existing code, wherein said

5 one or more processors use said existing code to operate said article of manufacture, and

6 wherein said existing code includes a Concurrent Code Load having (N) phases, the

7 computer readable program code comprising a series of computer readable program steps

8 to effect:

9 receiving a code update image comprising a Temporal Coupling File, wherein

10 said Concurrent Code Load includes instructions to read said Temporal Coupling File;

11 executing the (i)th phase of said Concurrent Code Load, wherein (i) is greater

12 than or equal to 1 and less than or equal to (N), and wherein (i) is initially set to 1;

13 determining if said (i)th phase of said Concurrent Code Load invokes said

14 Temporal Coupling File;

15 operative if said (i)th phase of said Concurrent Code Load invokes said Temporal

16 Coupling File, reading instructions for said (i)th phase of said Concurrent Code Load

17 from said Temporal Coupling File, and executing said instructions for said (i)th phase of

18 said Concurrent Code Load;

19   completing said (i)th phase of said Concurrent Code Load;

20   ascertaining if (i) equals (N);

21   operative if (i) equals (N), operating said information storage and retrieval system

22 using said code update.

1   12.   The article of manufacture of claim 11, said computer readable program

2   code further comprising a series of computer readable program steps to effect if (i) does

3   not equals (N):

4   incrementing (i);

5   repeating said executing, determining, completing, and ascertaining steps, and

6   optionally said reading, executing, and incrementing steps.

1   13.   The article of manufacture of claim 11, wherein said Concurrent Code

2   Load includes (N) indicators, wherein each of said (N) indicators is assigned to a

3   different one of said (N) phases, and wherein each of said (N) indicators can have a first

4   value or a second value, wherein said computer readable program code to determine if

5   the (i)th phase of the Concurrent Code Load invokes the Temporal Coupling File further

6   comprises a series of computer readable program steps to effect:

7   examining the (i)th indicator;

8   operative if said (i)th indicator is set to said first value, ascertaining that the (i)th

9   phase of the Concurrent Code Load does not invoke the Temporal Coupling File; and

10   operative if the (i)th indicator is set to said second value, ascertaining that the (i)th

11   phase of the Concurrent Code Load does invoke the Temporal Coupling File.

1   14.   The article of manufacture of claim 11, said computer readable program

2   code further comprising a series of computer readable program steps to effect:

3   installing said existing code at a first time;

4   receiving said Temporal Coupling File at a second time, wherein said second time

5   is later than said first time.

1   15.   The article of manufacture of claim 11, said computer readable program

2   code further comprising a series of computer readable program steps to effect:

3   receiving a code update image comprising the (m)th code update, wherein said

4   Temporal Coupling File includes instructions which cause said processor to determine if

5   the (m-1)th code update has been installed.

1   16.   The article of manufacture of claim 15, said computer readable program

2   code further comprising a series of computer readable program steps to effect generating

3   an error message if the (m-1)th code update has not been installed.

1   17.   The article of manufacture of claim 11, further comprising one or more

2   disk arrays and two or more clusters, wherein each of said two or more clusters includes,

3   a processor, one or more device adapters interconnected to said one or more disk arrays,

4   and said existing code, and wherein said Concurrent Code Load includes quiescing I/O to

5   a first one of said two or more clusters, said computer readable program code further

6   comprising a series of computer readable program steps to effect:

7   determining by a controller disposed in said first cluster if one or more device

8   adapters disposed in a second one of said two or more clusters are operational before said

9   first processor quiesces I/O to said first cluster;

10   wherein said Temporal Coupling File includes instructions which cause said first

11   processor to determine if one or more device adapters disposed in said second cluster are

12   operational before quiescing I/O to said first cluster.

1   18.   The article of manufacture of claim 17, said computer readable program

2   code further comprising a series of computer readable program steps to effect generating

3   an error message if one or more device adapters disposed in said second cluster are not

4   operational.

1   19.   A computer program product usable with a usable with a programmable

2   computer processor having computer readable program code embodied therein to update

3   code in an information storage and retrieval system while that information storage and

4   retrieval system remains in normal operation, said information storage and retrieval

5   system further comprising one or more processors and existing code, wherein said one or

6   more processors use said existing code to operate said information storage and retrieval

7   system, and wherein said existing code includes a Concurrent Code Load having (N)

8   phases, comprising:

9   computer readable program code which causes said programmable computer

10   processor to receive a code update image comprising a Temporal Coupling File, wherein

11   said Concurrent Code Load includes instructions to read said Temporal Coupling File;

12 computer readable program code which causes said programmable computer

13 processor to execute the (i)th phase of said Concurrent Code Load, wherein (i) is greater

14 than or equal to 1 and less than or equal to (N), and wherein (i) is initially set to 1;

15 computer readable program code which causes said programmable computer

16 processor to determine if said (i)th phase of said Concurrent Code Load invokes said

17 Temporal Coupling File;

18 computer readable program code which, if said (i)th phase of said Concurrent

19 Code Load invokes said Temporal Coupling File, causes said programmable computer

20 processor to read instructions for said (i)th phase of said Concurrent Code Load from said

21 Temporal Coupling File, and execute said instructions for said (i)th phase of said

22 Concurrent Code Load;

23 computer readable program code which causes said programmable computer

24 processor to complete said (i)th phase of said Concurrent Code Load;

25 computer readable program code which causes said programmable computer

26 processor to ascertain if (i) equals (N);

27 computer readable program code which, if (i) equals (N), causes said

28 programmable computer processor to operate said information storage and retrieval

29 system using said code update.

1 20. The computer program product of claim 19, further comprising computer

2 readable program code which, if (i) does not equals (N), causes said programmable

3 computer processor to increment (i).

1   21.   The computer program product of claim 19, wherein said Concurrent

2   Code Load includes (N) indicators, wherein each of said (N) indicators is assigned to a

3   different one of said (N) phases, and wherein each of said (N) indicators can have a first

4   value or a second value, wherein said computer readable program code to determine if

5   the (i)th phase of the Concurrent Code Load invokes the Temporal Coupling File further

6   comprises:

7   computer readable program code which causes said programmable computer

8   processor to examine the (i)th indicator;

9   computer readable program code which, if said (i)th indicator is set to said first

10   value, causes said programmable computer processor to ascertain that the (i)th phase of

11   the Concurrent Code Load does not invoke the Temporal Coupling File; and

12   computer readable program code which, if the (i)th indicator is set to said second

13   value, causes said programmable computer processor to ascertain that the (i)th phase of

14   the Concurrent Code Load does invoke the Temporal Coupling File.

1   22.   The computer program product of claim 19, further comprising:

2   computer readable program code which causes said programmable computer

3   processor to install said existing code at a first time;

4   computer readable program code which causes said programmable computer

5   processor to receive said Temporal Coupling File at a second time, wherein said second

6   time is later than said first time.

1   23.   The computer program product of claim 19, further comprising computer

2   readable program code which causes said programmable computer processor to receive a

3   code update image comprising the (m)th code update, wherein said Temporal Coupling

4   File includes instructions which cause said processor to determine if the (m-1)th code

5   update has been installed.

1   24.   The computer program product of claim 23, further comprising computer

2   readable program code which causes said programmable computer processor to generate

3   an error message if the (m-1)th code update has not been installed.

1   25.   The computer program product of claim 19, further comprising one or

2   more disk arrays and two or more clusters, wherein each of said two or more clusters

3   includes, a processor, one or more device adapters interconnected to said one or more

4   disk arrays, and said existing code, and wherein said Concurrent Code Load includes

5   quiescing I/O to a first one of said two or more clusters, further comprising:

6   computer readable program code which causes said programmable computer

7   processor to determine by a controller disposed in said first cluster if one or more device

8   adapters disposed in a second one of said two or more clusters are operational before said

9   first processor quiesces I/O to said first cluster;

10   wherein said Temporal Coupling File includes instructions which cause said first

11   processor to determine if one or more device adapters disposed in said second cluster are

12   operational before quiescing I/O to said first cluster.

1   26.   The computer program product of claim 25, further comprising computer

2   readable program code which causes said programmable computer processor to generate

3   an error message if one or more device adapters disposed in said second cluster are not

4   operational.